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EASTERN KENTUCKY UNIVERSITY

Where Words Fail, Music Speaks: The Impact of Music Intervention on Speech Therapy

Outcomes

Honors Thesis

Submitted

In Partial Fulfillment

Of the

Requirements of HON 420

Spring 2022

By

Jenna Johnson

Mentor

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Communication Sciences and Disorders Program

Department of Clinical Therapeutic Programs

# Where Words Fail, Music Speaks: The Impact of Music Intervention on Speech Therapy

## Outcomes

Jenna Johnson

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Abstract description: Within this thesis, the benefits of music-based intervention used within speech therapy sessions is explored through the study of neurology, literature reviews, and research data. The neurological pathways of speech and music depend on common processes in the mind; this relationship could potentially reveal benefits when using certain music activities in speech therapy sessions. The neurological link between language and music has been implemented in studies in speech therapy clients with fluency disorders (stuttering), patients with Parkinson's disease, and children with autism spectrum disorders (ASD). However, there is a shockingly small number of studies surrounding patients with speech sound disorders, one of the most common populations treated in the field of speech therapy. These studies, along with an analysis of neurological pathways involved in both music and speech processing, provided knowledge that guided independent research with a client in the Eastern Kentucky University Speech-Language-Hearing Clinic with an articulation disorder. Data was collected to assess the use of auditory bombardment through song and musical instruction during speech therapy sessions with this client. The use of these musical interventions showed an increase in both motivation and enjoyment of speech therapy; an increase in these areas of client response correlates with an increase in progress towards speech therapy goals. While there are many limitations to the study that do not allow the results

to be generalized, there are many evident benefits of music intervention in speech therapy sessions that have been identified through this study.

*Keywords and phrases:* Speech Language Pathology, music therapy, articulation disorders, speech sound disorders, auditory bombardment, neurology, music intervention, communication disorders

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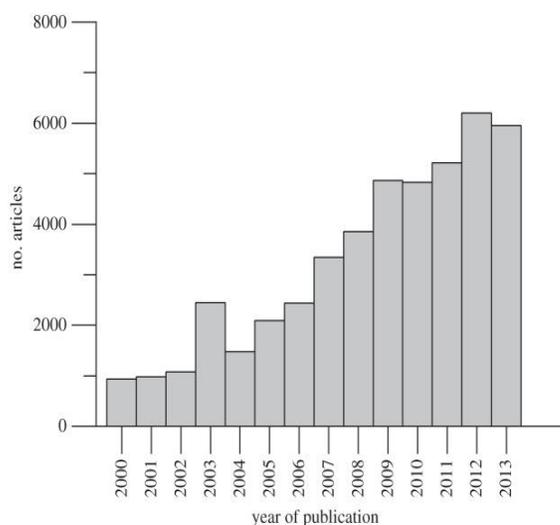
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## **Introduction**

Speech-Language Pathologists are trained to work in collaboration with many other professionals in order to provide co-treatments for clients; among these professionals include physical therapists, occupational therapists, audiologists, behavioral specialists, and more. In the past two decades, a shift in focus in brain science research has introduced a new facet of rehabilitation that is being increasingly considered in therapy: music. In fact, scholarly resources can provide evidence that there has been an increase in research surrounding the idea that music and language share neural networks; A Google Scholar search using the keywords ‘(neural) AND (overlap OR sharing) AND (music) AND (language OR speech)’ has increased linearly in published articles since 2005 (Peretz et al., 2015) (figure 1).



**Figure 1:** Results of a Google Scholar search. The search was performed on 11 July 2014 using the keywords ‘(neural) AND (overlap OR sharing) AND (music) AND (language OR speech)’, with the number of search results plotted per year (Peretz et al., 2015).

Specifically regarding communication, music therapists use elements of music, such as tempo, melody, and rhythm to improve and promote both receptive and expressive communication skills (Smith, 2011). Considering that speech and language are similar to music in many ways in regarding structure and neurological function, it is reasonable that research surrounding music and speech therapy collaborations have promoted positive outcomes for the various populations that require services from Speech-Language Pathologists. Based off these research outcomes, it is evident that music and language in collaboration unlock a new potential in speech therapy clients that is not cultivated with speech and language intervention alone. However, one issue with co-treatment is that professionals are not always available to collaborate with; music therapists may not be available in certain areas or cannot work with clients if there are schedule conflicts or funding limitations. In this case, Speech-Language Pathologists can potentially utilize music in communication interventions. The activities used in music therapy can be used as a complementary and supporting method of intervention in speech

therapy sessions. The utilization of music interventions by Speech-Language Pathologists can strengthen language, communication, and social skills for various populations; the focus of this individual study is to investigate the effect of musical interventions in speech therapy sessions for a school age articulation client. This project will first investigate the neurological linkage between speech and music processing that allows music intervention to be effective. Then, an analysis of current studies involving music and speech therapy clients of varying disorders. Finally, a review of research processes, data, and conclusions will be discussed to convey the knowledge gained from this study.

### **Neurological Pathways of Speech and Music Processing**

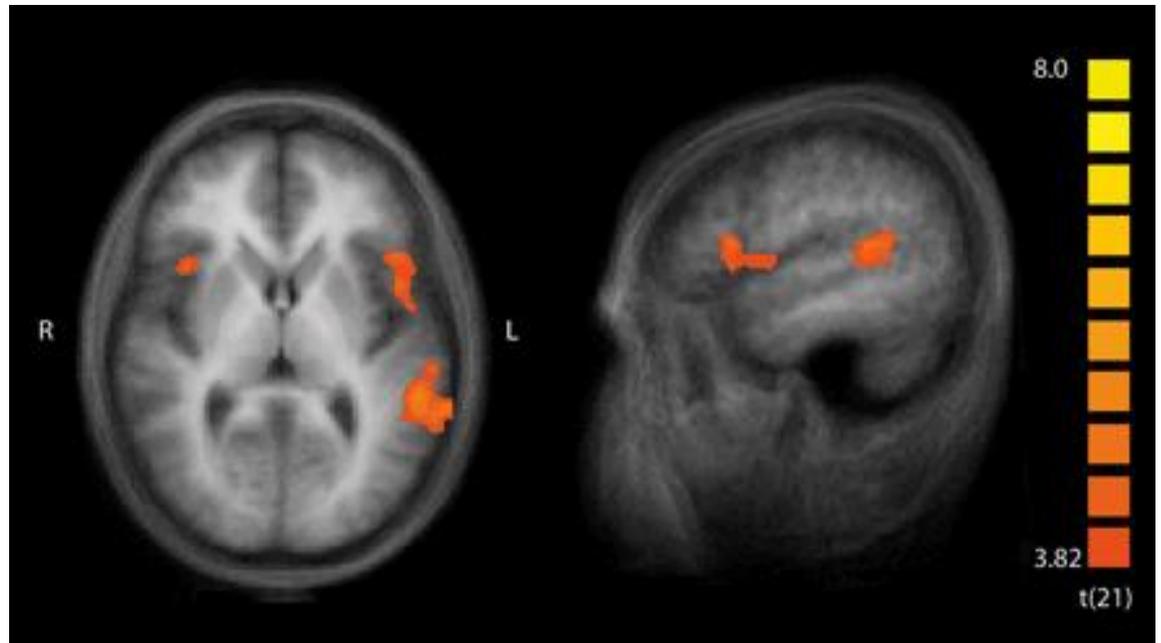
The basis of my argument begins with the neurological link between music and language. For years, neurological research has operated with the overarching belief that each brain region is specified for a function (Peretz et al., 2015). For example, the superior temporal sulcus is associated with voice processing, the Broca's area is associated with speech processing, and so on. However, the use of functional magnetic resonance imaging (fMRI), electroencephalography (EEG), and other techniques for mapping brain activity in recent studies have revealed that areas of the brain that were once believed to be language-specific are activated by music processing (Besson et al., 2011). Considering the similarities between language and music, this discovery is not much of a surprise at all.

Perhaps the neurological link between language and music is more understandable when considering comparable aspects of music and language. Music and language both consist of several different neurological aspects that must be processed at the same time;

in language, the understanding of phonology, semantics, syntax, and pragmatics are comparable to that of rhythm, melody, and harmony in music. Additionally, both music and language are auditory in nature, and rely on the same auditory processing areas of the brain to assess acoustic features such as pitch, duration, and intensity (Frontiersin.org).

A 2012 study from the Mediterranean Institute of Cognitive Neurosciences investigated rhythm, a critical characteristic of both music and speech, and the neurological areas associated with rhythmic processing in music. Similar to language, music is a rule-based and structured system; in this study, rhythm - one of the governing systems of music – was studied using neuroimaging in hopes to observe what areas are used during music processing.

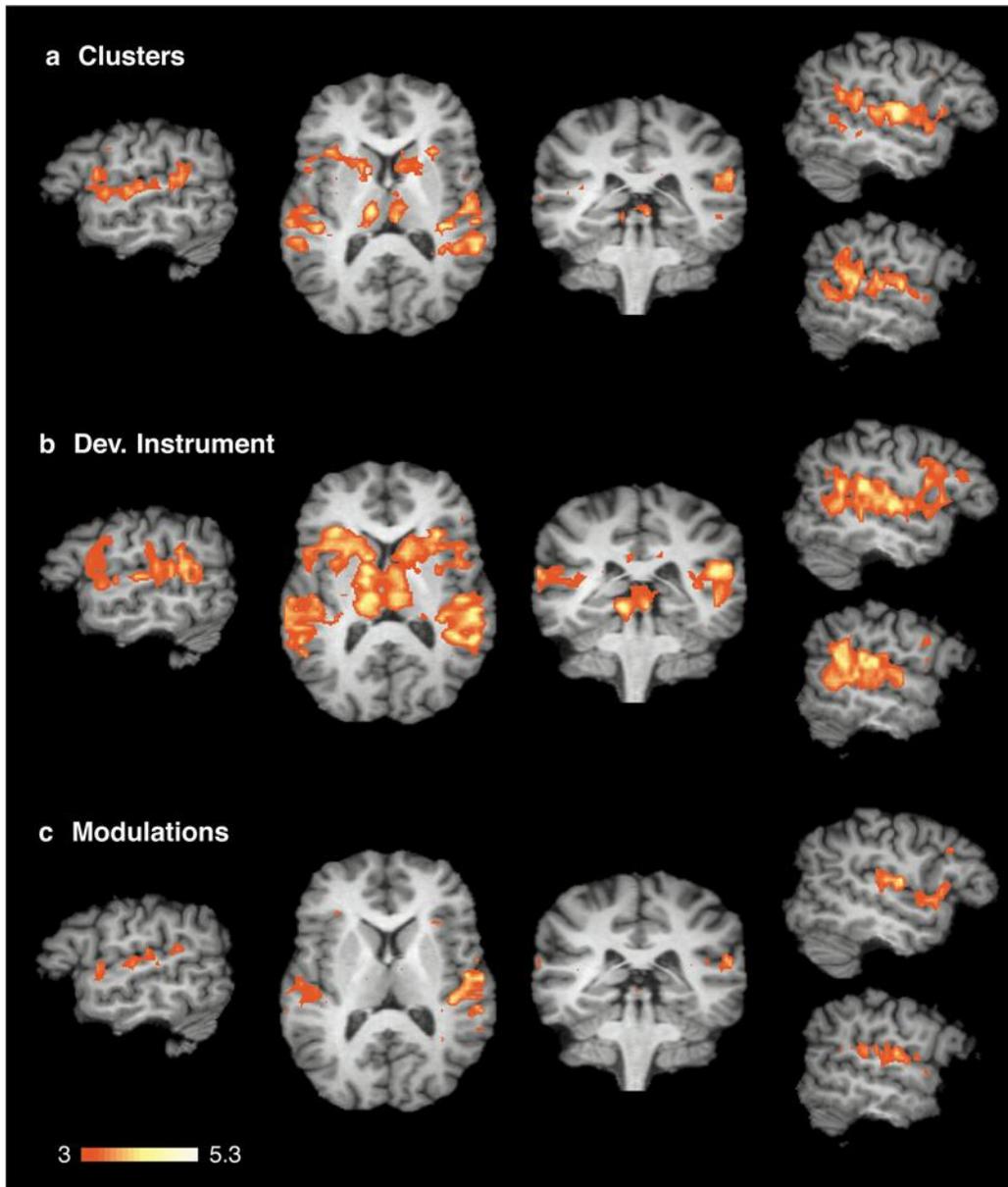
A group of 22 subjects, both musicians and non-musicians, were played two types of rhythmic variations through drum recordings: one with syncopated deviations (meaning the beats were in rhythm with the recording) and one with musically incorrect beats (meaning the beats were not related to the rhythm in the recording). Neuroimaging showed that, as an overall effect observed on the group of subjects studied, the occurrence of musically correct beats activated the right posterior superior temporal gyrus (STG), while incorrect beats activated the posterior STG of both hemispheres and, moreover, regions corresponding to the Broca's area – both critical brain areas related to speech and language processing (Figure 2).



**Figure 2:** Brain regions processing violations of rhythmic structure in music. (Herdener et al, 2012).

Similar activations have been observed in studies related to violations of language structure, which suggests that a shared brain region exists between music and language analysis. In a discussion of study results, researchers concluded that “as language and music....are based on a rule-based arrangement of acoustic signals, it is thus conceivable that the brain uses shared resources for analysis of such rule-based organization in both domains” (Herdener et al, 2012).

A similar study from Harvard Medical School used fMRI imaging to study brain response to unexpected musical events. A recording of chord sequences was played to ten non-musicians who were then asked to identify deviations (chords that were out-of-key) to these sequences. fMRI imaging showed that deviation events activated the areas of Broca and Wernicke, the superior temporal sulcus, Heschl’s gyrus, and several other brain areas (Figure 3) (Koelsch, 2000).



**Figure 3:** fMRI imaging of brain regions activated in response to differing unexpected musical events: clusters (a), deviant instruments (b) and modulations (c). (Koelsh et al., 2002.)

These are some of the same brain structures activated in the previously mentioned study, yet the studies were focused on completely differing aspects of music; these areas have also been thought to be domain-specific for speech and language information processing. However, fMRI data from this study shows that these neural areas are

employed for the processing of musical information as well; this supports the idea that language processing is not as domain specific as once believed (Koelsch, 2002.).

Since it has been proven through many studies that there are shared neural processing areas between language and music, there is still one question: how does this knowledge enhance speech therapy techniques? The answer to this question lies in studies of musical intervention motivated by the OPERA hypothesis. The OPERA hypothesis, first presented by the Neuroscience Institute of San Diego, focused on how music training enhances auditory sensory processing and neural plasticity (the ability of the brain to re-wire itself), which in turn improves speech processing. However, the OPERA hypothesis only works if five conditions are met: **O**verlap, **P**recision, **E**motion, **R**epetition, and **A**ttention (Patel, 2014). Overlap refers to the neural sharing of brain networks that process acoustic information for both music and speech; precision refers to how the demands of music processing are more precise than that of speech processing; emotion refers to the condition that musical activities must elicit strong – and positive – emotion; repetition refers to the frequent repetition of musical activities, and attention refers to the focused attention needed to activate neural networks for processing (Patel, 2012). The authors of the OPERA hypothesis proposed that “music training enhances auditory working memory and auditory attention, and that this impacts speech processing because speech and music have overlapping brain networks involved in these processes” (Patel, 2014). In other words, when these conditions are met by musical activities, according to the OPERA hypothesis, the networks of musical processing are strengthened; since speech processing shares these networks, speech processing abilities also benefit.

This hypothesis, as well as the knowledge gained from many studies surrounding the neurological networks shared between music and language processing, have been expanded to inspire studies within the field of speech pathology. Now that the basis of purpose and benefit behind musical intervention has been explored, discussion can now move onto field-specific studies surrounding musical intervention.

### **Music Intervention in the Treatment of Various Populations**

The use of music interventions in speech therapy can be applied to the various populations that speech therapists serve. Although this study focuses on speech production outcomes, music intervention has cultivated positive outcomes in speech therapy for various other populations of clients. Significant research regarding music intervention has been conducted within the treatment of many differing populations and environments, varying from post-stroke recovery to transgender voice therapy. The literature review for this study is based on music interventions that utilize the neural connection between music and speech processing. These populations include stroke survivors, patients with Parkinson's disease, and children with ASD. The review of these research studies will work to inform research design for this thesis based on the integration of music intervention in past studies.

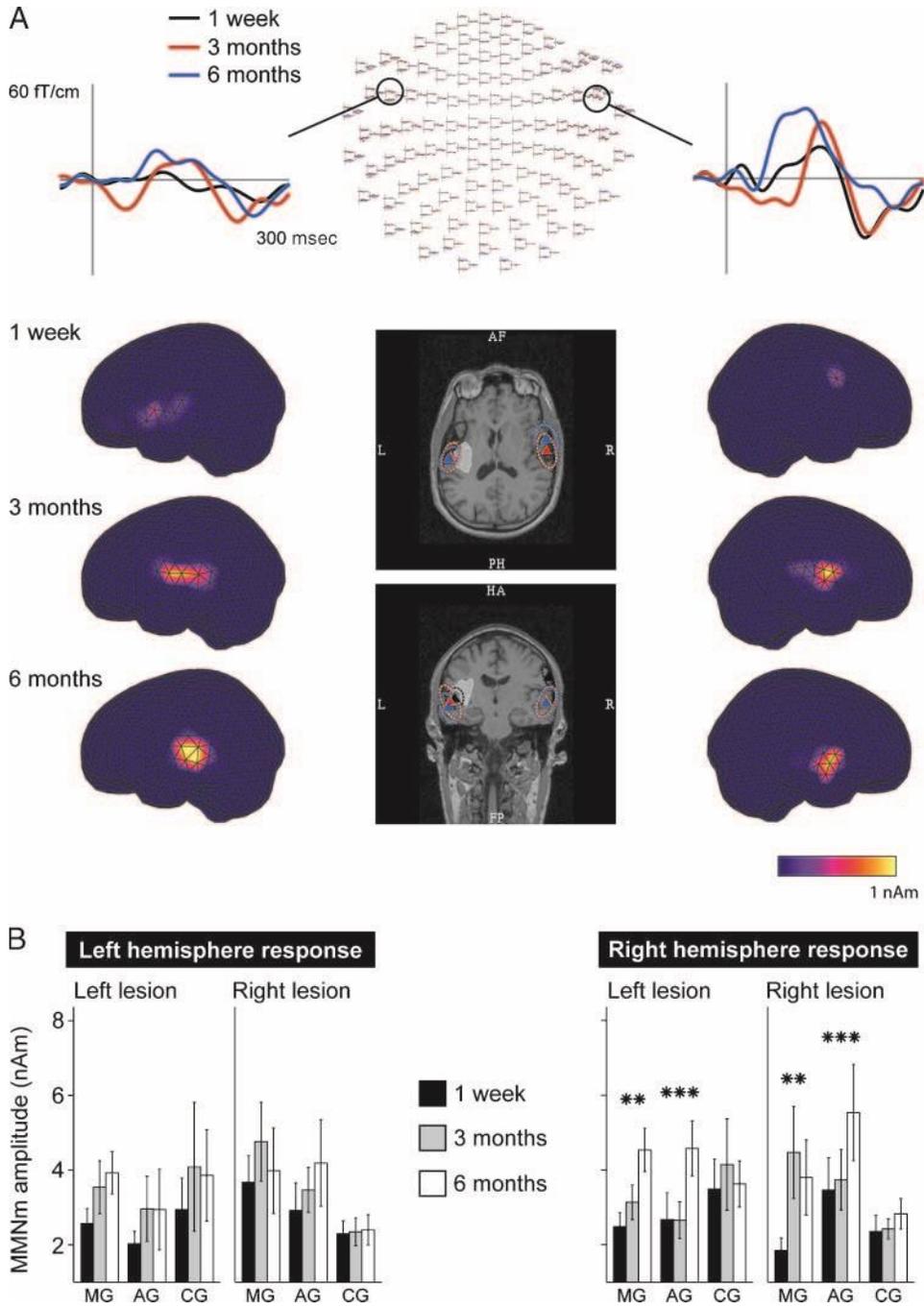
### **Music Intervention in Post-Stroke Recovery**

Stroke patients are a varied population that speech therapists work with in both in-patient and out-patient rehabilitation settings. Both music and auditory environment influence cognitive skills, therefore the use of music intervention in clients with neural

damage has the potential to re-develop critical skills affected by a stroke event. The use of music intervention can be used in post-stroke recovery environments in order to study the long-term effects of music therapy on the regaining of skills lost after neural damage.

In a 2010 study from the Massachusetts Institute of Technology, professionals wanted to determine if daily music and audiobook listening would help patients to regain auditory sensory memory, as well as verbal memory and focused attention skills, in patients after a stroke. Sixty patients who were diagnosed with a middle cerebral artery (MCA) stroke were randomly assigned to a music listening group, an audiobook listening group, and a control group. The patients' response to intervention was measured at the 1 week, 3-month, and 6-month mark of recovery since this is believed to be an optimal time for recovery progress prior to a stroke event. These responses were recorded using magnetoencephalography (MEG) neuroimaging techniques to map neural activity in participants at each stage of recovery (Sarkamo et al., 2010).

Research tests regarding MEG frequency increases between stages of recovery showed increase in activity in both hemispheres of the brain for the music and audiobook listening groups. MEG amplitudes increased significantly between the one week to the six-month stage of recovery for both groups; additionally, the change scores for the music group increased frequency significantly more than both the audiobook group and control group (Figure 4). Therefore, both music and audiobook listening increased neural response related to auditory sensory memory as measured through MEG frequencies.



**Figure 4:** Frequency MMNm at different stages of stroke recovery. (A) MCE analysis at the 1-week, 3-month, and 6-month poststroke stage. (B) Group results of the amplitude of the frequency of response in the left and right hemispheres. Data (mean ± SEM) are shown separately for LHD and RHD patients. \*p < .05, \*\*p < .01, \*\*\*p < .005

MG = Music group; AG = Audio book group; CG = Control group (Sarkamo et al., 2020).

According to the findings of this study, both daily music and audiobook listening after an MCA stroke led to an increase in auditory sensory memory. The increase of neural activity in brain areas affected by stroke events, as well as progress in performance during activities with story recall and word list learning, supports the idea that music intervention can help to recover skills after a stroke. Complex auditory stimuli, such as music and speech, place strong demands on both speech comprehension and working memory; the daily exposure of patients to auditory stimuli helped to strengthen these skills, which are closely related to and implement auditory sensory memory.

Additionally, researchers concluded that an enriched acoustic environment helped to improve auditory, learning, and memory function. These conclusions are derived from the observation of significant increase of MEG activity in both hemispheres, as both music and speech listening activate the brain bilaterally (Sarkamo et al., 2010). This helps neurologists to determine the positive impact that music intervention has on stroke recovery as well as contributing to evidence of a link between speech and music processing that can be implemented in speech therapy.

An additional study from the American Speech-Language-Hearing Association (ASHA) is more focused on the impacts of music intervention on stroke recovery within the field of speech language pathology. Strokes often cause damage to an area of the brain mentioned earlier: Broca's Area. This area is a critical neural area responsible for speech motor movement. When neurological damage occurs to this area of the brain, the ability to understand and communicate using speech is called Broca's Aphasia. Patients with Broca's Aphasia may be able to understand what is being said but cannot speak fluently because the area that controls the fluency and motor planning of speech is

damaged. Many patients with Broca's Aphasia have been observed to retain the ability to sing despite the damage to the speech motor area; this led to the development of a therapy technique called Music Intonation Therapy (MIT), which utilizes a patient's ability to sing in order to produce speech output (Conklyn et al., 2012).

In the 2012 ASHA study, 30 stroke survivors with Broca's Aphasia were assigned to receive MIT during the early recovery period of post-stroke therapy. Treatment consisted of 15-minute MIT sessions; within these sessions, therapists would model a phrase (ex. "I need a drink of water") and instruct the participant to sing the phrase back (Conklyn et al., 2012). Treatments occurred over 4 sessions. Speech assessments were given before and after the study in order to assess skill areas, such as responsiveness and recall. The responsive section contained 3 questions designed to elicit speech output responses, such as, "When you are thirsty, what do you say when the nurse comes in?" The repetition section contained three statements that correspond to the questions in the prior section, such as "I need a drink of water," that the participants were instructed to repeat exactly after the phrases were modeled for them (Conklyn et al., 2012).

In comparing the pre- and post- assessment data for treatment and non-treatment groups, MIT techniques produced significant improvements after just one session of training. While there was a minimal gain in the repetition section for the control group, the treatment group saw significant gain in both responsiveness and recall abilities; researchers credited the application of skills taught in MIT techniques to the assessment tasks for this gain in skills.

Early MIT training, through analyzation of this data, unlocks the communication potential of patients with Broca's Aphasia by unveiling alternate means of

communication, such as singing. The results of this study show that music intervention demonstrates positive results in improved verbal output for patients with Broca's Aphasia. This is an important contribution to the nature of my study, as using the neurological link discussed throughout this study, MIT is able to access areas of the brain to communicate even when speech areas of the brain are damaged.

### **Music Intervention in Parkinson's Disease**

Another aspect of music intervention addressing neurological rehabilitation can be discussed in context of clients with Parkinson's disease (PD), which is a progressive neurodegenerative disease with no cure currently. The aim of therapy is to minimize the effects of PD – in essence, “slow down” the progression of the disease. The disease significantly affects body movement and mental agility, which poses many challenges to daily life (Panebianco & Lotter, 2019). Music intervention for individuals with PD focuses on both motor and nonmotor goals by using rhythm as a cueing strategy for motor control and coordination and singing for improvement in vocal expression skills, such as speech fluency, clarity, and volume (Panebianco & Lotter, 2019). These techniques inspired a case study to increase daily life and functioning for a client with PD in South Africa.

In this case study, a client at the University of Pretoria in South Africa attended eight 60-minute weekly therapy sessions with multiple music interventions to address the therapy goals related to the client's diagnosis of PD. These interventions included structured drumming and instrumental exercises, musical improvisations, music-centered movement, music listening, and vocal work through pre-composed music (Panebianco &

Lotter, 2019). These interventions targeted three core components of music intervention: active music therapy, music-centered movement, and receptive music therapy; these three core components have been observed in past studies to prevent the declination of function in patients with PD.

The skills that emerged through these musical interventions are all related to improvement in everyday functionality. Tempo and rhythm interventions helped improve the client's movement regulation and control; walking exercises helped the client to improve regulation of a walking pace by following the tempo cues of music. Vocal exercises helped the client to increase articulation control and voice projection. Singing intervention showed an increase of fluency and breath control (Panebianco & Lotter, 2019).

Researchers concluded that the improvements observed in this case study demonstrated the therapeutic potential of music intervention when addressing both motor and non-motor functions of patients with PD. At the end of the study, researchers reported an increase in patient motivation as well, stating that the client "requested ongoing personal music therapy, which continued for two years, developing what was established during research intervention" (Panebianco & Lotter, 2019). The increase in functionality and motivation are two important client factors in therapy that support the integration of music therapy in the treatment of patients with PD.

An additional study from the UK National Health Service set out to determine if group singing lessons would provide effective speech therapy for patients with PD. Researchers believed that singing would improve the four domains of speech - respiration, phonation, facial movement, and articulation – that are negatively impacted

as the disease progresses. Researchers defined six areas of concern regarding voice skills with PD: control, diction, sound, breath, and posture. Each session contained exercises for each of these areas. Sessions occurred for the duration of 2-hours every two weeks over the course of two years. Participants were assessed prior to and after intervention using the Frenchay Dysarthria Assessment, which measures a patient's response ability to perform various oral tasks (Evans et al., 2011).

An assessment completed after the second year of the study revealed improvements in several aspects of oral communication. Significant improvements in dribble, laryngeal pitch, laryngeal volume, and laryngeal speech (clear and appropriate speech during conversation) were all noted in the results of this study (Figure 5) (Evans et al., 2011).

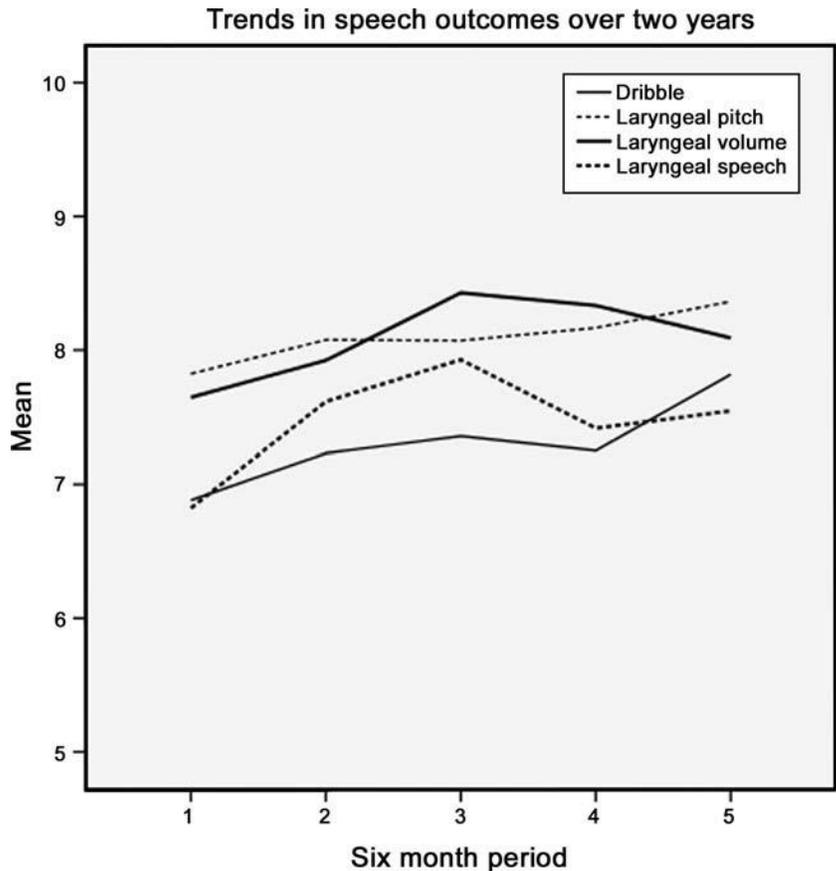


Figure 5: Trends in speech outcomes over two years. (Evan et al., 2011)

This study provides further evidence that music therapy, specifically through voice exercises, prevents the deterioration of voice quality in progressive neurological diseases such as PD (Evans et al., 2011). As speech is a vital aspect of communication, preserving the skills needed to effectively communicate orally is an important benefit of music intervention for the PD population.

### **Music Intervention in Services for Children with Autism Spectrum Disorder (ASD)**

The final population of studies, and perhaps the most researched, regarding music intervention surround services provided for individuals with ASD. Many Speech-Language Pathologists have begun to integrate music therapy into their treatment of children with ASD. Music therapists have been inspired to integrate their services into treatment of children with ASD due to the many neurological studies that provide evidence of preserved musical skills in individuals with autism (Sharda et al., 2015).

Using passive listening fMRI techniques, 22 children with autism, demonstrating varying levels of functioning, were tested during spoken word and sung word activities. Neural imaging found that the areas of the brain that process speech were more engaged during song activities than speech activities; additionally, neural activity was disrupted when listening to speech, but there were no differences from typical brain activity noted when listening to sung language (Sharda et al., 2015). These findings suggest that music intervention can help children with ASD overcome speech and language deficits and help to further develop these skills. This study provides a neurological basis for the

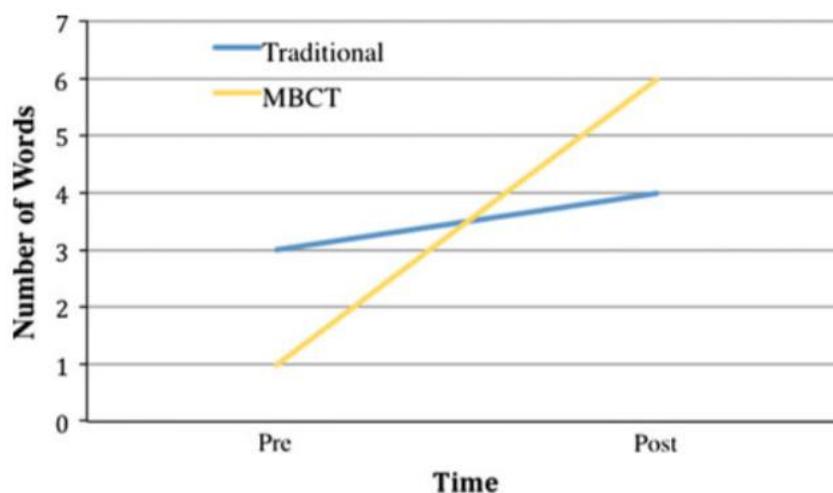
development of musical interventions used in the studies that are to follow (Sharda et al., 2015).

Although ASD includes a wide spectrum of disorders with a variety of characteristics and abilities, a common deficit associated with ASD occurs within communication. Delays in communication ability can affect development of important skills in the domains of socialization, cognitive, and emotional development that helps a child with ASD understand the world and people around them (Khyzhna & Shafranska, 2020). The realization of the benefits of music therapy for this population has led to its popularity among speech pathologists and music therapists alike, even inspiring an inclusive music-intensive camp for children with ASD at Ohio University (Brown et al., 2018).

The increase in implementation of music intervention for clients with ASD has led to many studies that provide evidence of a positive impact on communication when music is integrated into treatment. One such study from the Communication Sciences and Disorders department at Loma Linda University focused on the validity of Melodic Based Communication Therapy (MBCT) for children with ASD who do not use verbal communication. The percentage of children with Autism who lack functional speech abilities has risen to an estimated 30-50% of all children with ASD. For children with ASD, if oral communication abilities have not developed by the age of 5, it is likely that speech and language acquisition will continue to be a significant concern. However, despite a child's age, it has been observed that nonverbal children with autism, as mentioned earlier, have preserved musical skills; that is what this study worked to utilize through MBCT (Sandiford et al., 2012).

Melodic Based Communication Therapy (MBCT) is a type of music intervention in which therapists sing to a standard melody for target words; this is often accompanied by rhythmic clapping to the melody. In this study, clients with ASD were randomly assigned to two groups: a traditional speech therapy group, and a MBCT group. Clients received 5 weeks of intervention consisting of weekly 45-minute sessions (Sandiford et al., 2012). Clinicians chose 25 target words based on frequency words commonly used by young children, such as “ball.” Progress was measured through administration of the Autism Diagnostic Observation Schedule (ADOS) before and after intervention; the ADOS is a standardized assessment of communication, social skills, and pretend-play skills of children with autism, commonly used to make an ASD diagnosis (Sandiford et al., 2012).

Prior to intervention, both groups demonstrated considerable progress in verbal attempts, number of correct words, and number of imitative attempts during assessment. However, there was a noticeable difference in progress rate between the two groups. In the MBCT group, considerable progress was observed after week one, week two, week three, and week four. In the traditional group, progress was only observed after week four (Sandiford et al., 2012). The amount of progress for the MBCT group for verbal attempts and word imitation was significantly greater than that of the traditional group (Figure 6) (Sandiford et al., 2012).



**Figure 6:** Median number of words imitated pre and post treatment by type of treatment (Sandiford et al., 2012).

The results of this study imply that melody and rhythm could potentially be factors in increasing the communication attempts at word level of children with ASD. Although the data for both groups reportedly plateaued after week 5 of treatment, the initial significant increase in word recognition for clients in the MBCT group suggests that music therapy provides progress more expeditiously than that of normal therapy techniques. The increase in communication skills when using MBCT could potentially be related to increased motivation, interest, and ability through music skills; the data reported in this study suggests that MBCT is a form of music intervention that is effective for children with autism.

Another study from the Hammill Institute on Disabilities focused on a group-based music intervention called the Vocal Interactive Communication and Social Strategies (VOICSS) method. VOICSS is a music therapy method where therapists use songs to teach social-emotional skills, speech, and communication skills (Schmid et al., 2020). A sample of 64 children between the ages of 5 and 11 with placements in special education classrooms were provided a 16-week intervention. The VOICSS method was

administered for 45 minutes each week during the 16-week intervention period. The Duke University Autism Communication and Socialization (DUACS) assessment was used as a measurement tool to determine gains in both communication and socialization skills for participants; this test was administered before and after the intervention period (Schmid et al., 2020).

Results of this study showed that participants demonstrated overall gains in language, communication, and social-emotional skills during the intervention period. In addition, students with higher initial DUACS scores showed a more rapid increase in skill gains. This provides evidence that higher-functioning children with ASD may benefit more quickly from music therapy; however, overall score gains in the DUACS assessments show that all participants, regardless of functioning, exhibited enhanced communication and social-emotional skills prior to intervention.

Regarding studies of music therapy for children with ASD, music is a valid form of therapeutic intervention that cultivates improvement in social, interpersonal, and cognitive skills. Benefits from these studies included increased social behavior, attention, vocalization, verbalization, and vocabulary, as well as increased communication and social skills, enhanced awareness, and improved self-care skills (Vries et al., 2015). The use of music intervention to enhance skill levels of children with ASD of various ages and functioning levels has proven to be a beneficial avenue of treatment.

### **Individual Research**

When beginning this project, specific interest was drawn from the successes of National Youth Poet Laureate, Amanda Gorman. Gorman is a 22-year-old Harvard

graduate who captivated the world with the reciting of her poem, “The Hill We Climb” at Joe Biden’s Presidential Inauguration in January 2021 (Smith, 2021). When attention was on the rise due to her performance, she shared in many interviews that she struggled with a speech disorder and an auditory processing disorder that made it difficult for her to pronounce and hear certain sounds in words, specifically the ‘r’ sound (Lovell, 2021). To overcome this challenge, Gorman creatively found a way to practice her “r” sound by rapping along to a famous song from the popular Broadway musical *Hamilton*: “Aaron Burr, sir.” Gorman admitted that she challenged herself to keep up, saying “I would try to keep up with Leslie Odom Jr. (the original Aaron Burr actor on Broadway) ...I would say, if I can train myself to do this song, then I can train myself to say this letter” (Andrew, 2021). This creative technique provides more than just an entertaining way to practice sounds, according to Dr. Jonathon Preston from Syracuse University’s Communication Sciences and Disorders program. Dr. Preston attests to the fact that strategies such as rapping or reciting poetry, such as the strategies Gorman has implemented in her therapy, help to solidify clear speech sounds during production. When discussing Amanda’s techniques, he shared:

“Strategies such as poetry or rapping may be helpful to solidify clear productions once a person has learned the underlying articulatory movements of a sound. As Amanda states, repeating a song from *Hamilton* which is loaded with ‘r’ words helped her to rehearse the coordinated movements for clear speaking” (Lovell, 2021).

In fact, when reading the lyrics of this 3-minute song packed with ‘r’s, one may find that there are over 109 productions of the “r” sound within the song. This amount of data on

“r” production is a considerable amount greater than any other activity could elicit in 3 minutes. This type of musical intervention strategy for articulation disorders has little research surrounding it, despite the fact that the prevalence of speech sound disorders is estimated up to 48.2% of school-aged children (Baker et al., n.d.). While there are many cases surrounding other populations in speech therapy, there is a surprising gap surrounding one of the greatest areas of speech pathology’s population as a field. Therefore, inspiration was gathered from this lack of research in order to implement musical intervention into speech therapy sessions for a client with a speech sound disorder.

### **Auditory Bombardment and Musical Instruction**

According to Maszewka (2017), music therapy as an intervention type is considered to have four levels of impact: auxiliary, augmentative, intensive, and main. The auxiliary level is defined as any use of music that is not used for therapy but serves a related purpose. The augmentative level is defined as any use of music that supports other therapy activities and contributes to therapy outcomes. The intensive level is defined as any use of music that has an independent role in treatment. The main level is defined as any use of music that is significant to therapy and meeting the basic needs of a client (Maszewka, 2017). For the purpose of this project, the therapy techniques used will have an impact at the augmentative level; therefore, the activities used as musical intervention will contribute to the client’s goals overall but is not an independent aspect of therapy.

The first aspect of musical intervention considered is the use of auditory bombardment. Auditory bombardment, as defined by the American Speech-Language

Hearing Association, is a therapy technique in which target words are presented to the client in excess (Baker et al., n.d.). Auditory bombardment increases the client's exposure to correct production of target sounds, which increases the client's understanding of what these correct productions sound like; this, in turn, increases the client's ability to gain understanding of producing the sound his or herself. For this activity type, a YouTube video titled: "The R Song: Auditory Bombardment to Improve Pronunciation – Songs for Speech Therapy" was used as a therapy tool to allow the client to listen to the initial /r/ sound – r in the beginning of words – in many different targets. These words included words such as rock, rain, raisin, road, and more; the client was not asked to sing this song, but was instead asked to simply listen to the song at the beginning of each session where music intervention was used.

The second aspect of musical intervention considered in this project is the use of instruction through song. This aspect of musical intervention implements songs in order to provide instruction to a client rather than basic word instruction from the clinician. In this case, songs were used to teach the client how to say /l/ blends (bl, cl, gl, etc.), the 'th' sound, and /r/ at syllable level.

For the instruction of /l/ blends and the 'th' sound, YouTube videos were used from the YouTube channel "Jack Hartmann Kids Music Channel." In the /l/ blend video, the lyrics of the video provide instructions on how to break down individual sounds of the blend, put them together, and then place them at the beginning of words; for example, the chorus of the song is as follows:

"What is a blend? B says /l/, L says /l/, but them together it sounds like /bl/...like in blue, black...." (Hartmann, 2018).

An additional Jack Hartman song was used for the ‘th’ video, in which song instruction is as follows:

“Let’s learn about the digraph ‘th’. T says /t/, H says /h/, put them together it sounds like this.../th/, /th/, /th/...like on Thursday, Thursday, Thursday...I heard Thunder, Thunder, Thunder....” (Hartmann, 2017).

Since the lyrics were on the screen and the client was more advanced in these sound productions compared to /r/, the client was asked to sing along to these songs during their use in therapy. Data were collected on the accuracy of response during the singing of these songs.

The final musical intervention used was a program through Reading with TLC called “Lively Letters.” The “Lively Letters” program is an application installed on electronic devices; it is a “research-based and clinically proven” app that turns letters into characters with matching stories and songs (Lively Letters, n.d.). The use of Lively Letters was implemented for instruction surrounding the letter ‘r’ at syllable level; this character is a dog, relating the /r/ sound to a dog growling. The song implements instruction through the following lyrics:

“My sound’s very quick, my tongue’s up in the back, it’s a neat doggy trick!”

(Lively Letters, n.d.).

The teaching of the “neat doggy trick” in this song both provided instruction for tongue placement for the /r/ sound as well as a cue that can be used in traditional instruction to correct a client’s incorrect production: “Use your neat doggy trick!”

## **Research Approach and Methodology**

### *Aim*

- To ascertain if music intervention activities can effectively improve the accuracy of speech sound production for a client with an articulation disorder
- To assess whether music intervention activities make therapy sessions more enjoyable or increase client motivation

### *Objectives*

- To measure increase in speech sound production accuracy between music-centered sessions and non-music centered sessions
- To self-measure enjoyment, motivation, and other personal aspects of the client's response to the intervention

### *Study Design*

A single experimental case study with baseline and data collection over a period of 3 months (14 sessions). The client received speech therapy services for 50-minute sessions twice a week for 7 weeks; the use of music intervention was alternated between sessions to allow data comparison. Music and non-music sessions were alternated to collect data to compare.

### *Subjects and Procedure*

The subject is an elementary-age client enrolled in the Eastern Kentucky University Speech-Language-Hearing Center (EKU-SLHC) assigned to the single-student caseload of an EKU-SLHC Student Clinician. The client and their parents were informed verbally and through written information about the study, its purpose, and its

potential outcomes. Parents of the participant gave written consent for the client to participate; the client was read a verbal script to explain their option to participate in the study to obtain verbal consent. The project was approved by the ECU Institutional Review Board (IRB) Committee for research through 5/1/2022.

### *Interventions*

Musical interventions were chosen, reviewed, and approved by an ECU-SLHC supervisor in order to ensure effectiveness. Interventions focused on catering to the client's speech production and reading abilities. Interventions would be used to target /r/ at syllable level, initial /l/ blends, and initial /ð/ ('th'). Musical interventions would occur first during sound targeting, and flash card elicitation of sounds would occur after. As mentioned earlier, the following musical interventions were used in sessions:

- /r/ auditory bombardment song
- Lively Letters (/r/) song
- Jack Hartmann, "What is a blend?" song
- Jack Hartmann, "The Diagraph 'th'" song

Since the client attends the ECU-SLHC twice a week, the use of music intervention and non-music intervention was alternated between sessions. For /r/ musical interventions, the client was asked to only listen to both songs and accuracy was recorded directly after. This is due to the reduced ability of the client of /r/ production to syllable level; since songs focused on auditory bombardment and instruction of /r/, the client was not asked to actively participate in these activities aside from listening. For /l/ blend and initial /ð/ musical interventions, the client was asked to sing along with the songs played. Since the

client's ability is at word level for these sounds, the client was able to read and sing along to the lyrics and target words on the screen as the song played. Data was collected during these songs to assess accuracy during song.

### *Methods of Data Collection*

Data collection implemented the documentation procedures of the EKU-SLHC, including daily treatment notes, a plan of treatment report, and a progress report. At the beginning of the clinical experience, goals were set for each targeted sound within the client's Plan of Treatment document. Intervention did not stop once these goals were met; rather, data were still collected to assess the retainment and additional improvement of target sounds during intervention. The following goals were used to measure improvement of speech sound accuracy of the client throughout the study:

- The client will produce /r/ at syllable level at 80% (8/10 trials) accuracy for 2 consecutive sessions.
- The client will produce initial /l/ blends at word level at 80% (8/10 trials) accuracy for 2 consecutive sessions.
- The client will produce initial /ð/ at word level at 80% (8/10 trials) accuracy for 2 consecutive sessions.

Goals were based off the Kentucky Academic Standards of Reading and Writing, a document published by the Kentucky Department of Education in 2019. This document provides standards of skills divided by grade level; these standards describe what skills should be present in a child based on their level of education. The document describes

these standards as “general, interdisciplinary literacy expectations that must be met for students to be transition ready” from one grade to another (Almasi et al., 2019). The Grade-1 Reading Foundation Skills standards were used as a basis for goal setting, specifically section RF.1.2.b and RF 1.2.c under the Phonological Awareness standard.

These standards state that a child in 1<sup>st</sup> grade should:

“Demonstrate understanding of spoken words, syllables, and sounds (phonemes);  
b. Orally produce single-syllable words by blending sounds (phonemes),  
including consonant blends; c. Construct and deconstruct spoken single syllable  
words into initial, medial, and final sounds (phonemes)” (Almasi et al., 2019)

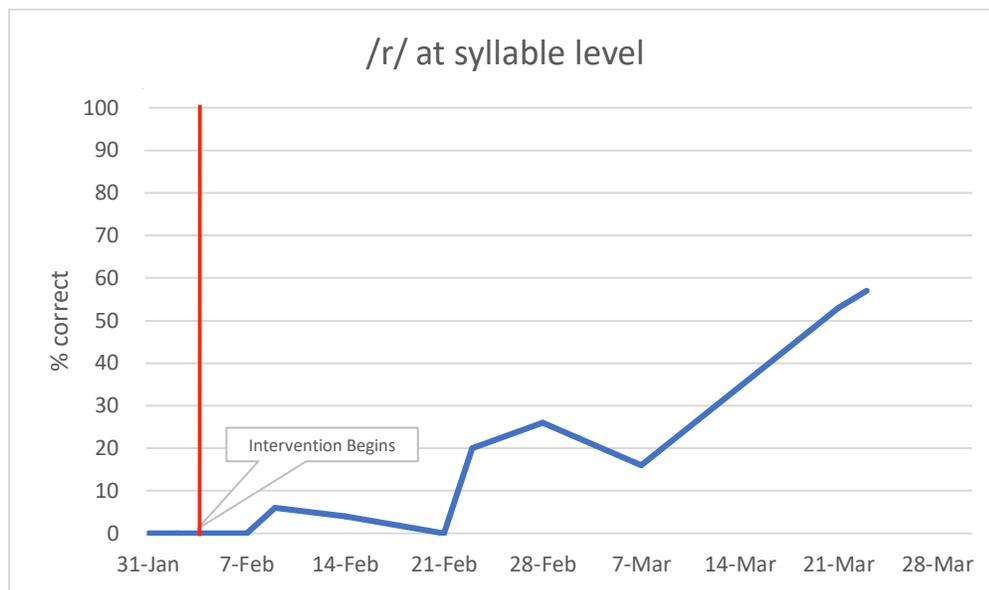
Binary (+/-) data were collected during musical and non-musical intervention to measure the percentage of correct productions of targeted sounds during each session. This data was recorded in daily treatment notes and accuracy was compared session-to-session to measure improvement and effect of intervention. Data were separated between musical and non-musical intervention data. For each sound targeted, 3 sessions of baseline data were collected prior to the beginning of musical intervention.

### *Data Analysis and Results*

The results are summarized in Figures 7-11. These figures are charted data of each targeted sound. For each intervention, there is a chart for overall data and a chart for data separated by intervention type.

For intervention of /r/ at syllable level, the use of auditory bombardment and musical instruction through song showed an increase in accuracy throughout the semester (Figure 7). Since the client was not asked to participate in these activities, data could not

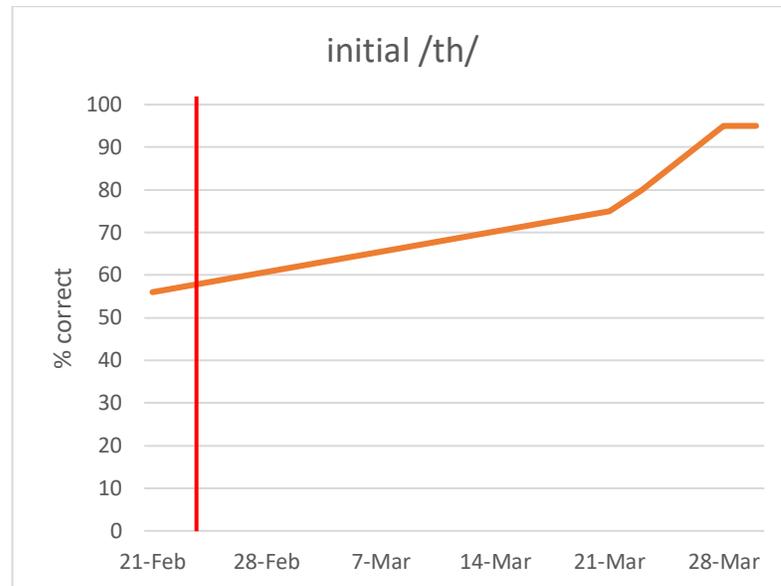
be separated into musical and non-musical data for intervention. However, Figure 7 shows a significant increase over the 14 sessions in accuracy of /r/ production at syllable level.



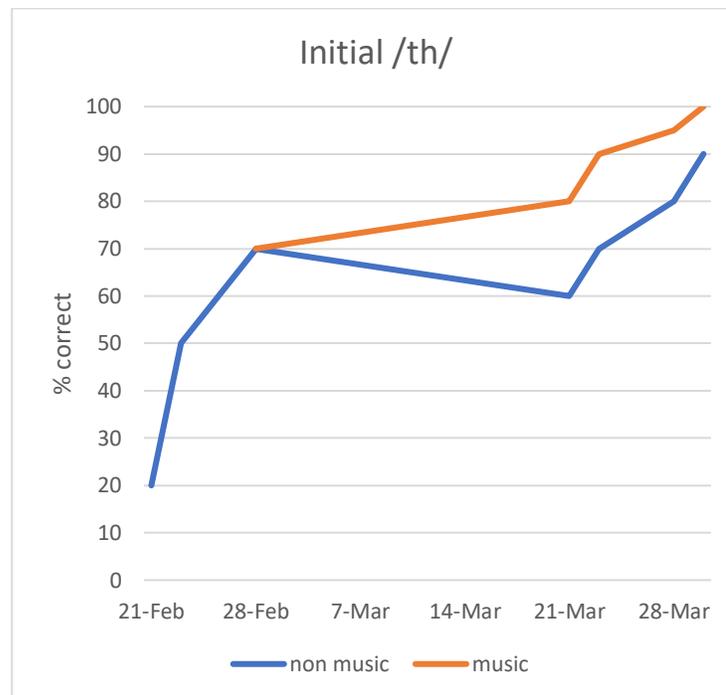
**Figure 7:** Data collected on percentage of correct productions for each session. The red line indicates the separation between baseline collection and the beginning of musical intervention.

For intervention of initial /ð/, the client participated in musical intervention through a song; this song included musical instruction of how to produce the ‘th’ sound as well as several target words. Figure 8 shows the data collected for initial /ð/ as a whole, with a red line indicating where intervention begins. This figure shows a significant increase in accuracy of production; the client met their goal of 80% accuracy on March 23<sup>rd</sup>, but further intervention showed that accuracy improved overall to 95% at word level. Figure 9 shows the data separated into data collected during sessions where musical intervention was used, and musical intervention was not used. This figure shows a significant difference between musical and non-musical intervention data, with data collected during musical intervention significantly higher than non-musical intervention

throughout the project. This shows that, as a whole, the client performed better during musical intervention compared to traditional intervention when targeting this sound.

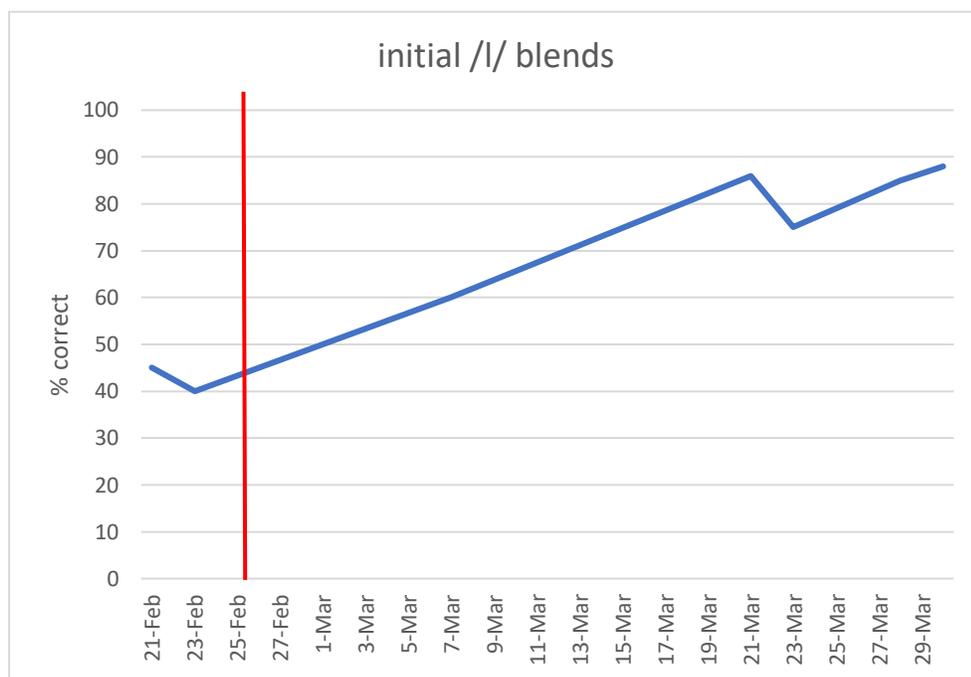


**Figure 8:** Data collected on percentage of correct production of initial /ð/ at word level. A red line indicates when musical-intervention begins.



**Figure 9:** Data separated between music intervention and non-music intervention sessions for initial /ð/ at word level.

Similar to that of initial /ð/, initial /l/ blend intervention included the use of song for musical instruction and production of target words. Figure 10 shows the data collected overall for accuracy of production of initial /l/ blends, with a red line indicating the start of musical intervention. Again, this figure shows a significant increase of production accuracy with the client meeting their goal for the targeted sound on March 17<sup>th</sup>. Further intervention found that the client increased overall production to 90% by the end of sessions. Figure 11 shows initial /l/ data separated into musical and non-musical intervention. A significant difference in accuracy percentage is once noted again between non-music and music data, with music data significantly and consistently higher than that of non-music intervention. This shows that, as a whole, the client performed better during musical intervention compared to traditional intervention when targeting this sound.



**Figure 10:** Data collected on percentage of correct production of initial /l/ blend at word level. A red line indicates when musical intervention begins.



**Figure 11:** Data separated between musical and non-musical intervention sessions for initial /l/ blends at word level.

As seen in both Figure 9 and 11, there is a trend present when data are separated between non-music and music intervention sessions. The data for music sessions seem to be a considerable amount higher than non-music session data. Based on these figures, it is reasonable to conclude that the client performed better during music sessions than non-music sessions overall. These results could be contributed to the fact that music, when used in intervention, contains factors that enhance attention skills, especially in school-aged children. According to a study from Kyoto University, a single 30-minute music intervention proved to increase controlled attention levels in school-aged children when compared to game-based intervention, which was used to elicit non-musical intervention data in this study (Kasuya-Ueba et al., 2020). Seeing that the client is among this age that appears to benefit the most from music intervention, the songs used in therapy may have contributed to improved focus and attention, which in turn improved speech sound production skills. Especially when comparing to the non-music approach, it is evident

that the client performed better when producing target words during song. Given the evidence of the neural link between speech and music, along with experimental data that supports increased attention during musical intervention, it appears that musical intervention was effective in improving the speech production skill of this client.

### *Client Interview*

Regardless of the effectiveness of musical interventions used in this study, it is important to understand how the client viewed the activities. A Speech-Language Pathologist's (SLP's) services do not stop at assessing and treating disorders; under ASHA's eight service delivery domain areas, an SLP's scope of practice includes the area of counseling. This includes educating, guiding and emotionally supporting clients as they undergo treatment (ASHA, 2016). Part of understanding the data and results of this study is to also understand the client's outlook on the interventions used. Client outcomes rely heavily on client enjoyment and motivation, as these underlying factors are what drive clients to participate in intervention and strive to perform well during sessions (Atherton & Hudock, 2022). If a client does not enjoy therapy interventions, it is not likely that they will feel supported nor motivated during therapy. Dr. Robert Fourie from the University College Cork in Ireland performed a study assessing the view of therapeutic relationships from the perspective of pediatric speech-therapy clients. In this study, he discussed the importance of the client's enjoyment on an intervention's effectiveness, saying:

“If speech-language pathologists are not aware of the child's perspective, and do not use such insight when implementing therapy, this may.... have a negative

impact on the implementation of tasks and the achievement of goals in speech-language therapy” (Fourie et al., 2011).

To assess the client’s enjoyment of the various musical interventions used, they were asked a series of interview questions (Table 1); these interview questions prompted the client to rate musical interventions as well as describe their ideas of personal performance during the interventions. The client was also asked to compare their experience during this study to past sessions with different clinicians and intervention types. Table 1 outlines these questions and non-verbatim responses recorded during the client interview.

INTERVIEW QUESTIONS	CLIENT RESPONSE
<b>Q:</b> on a scale from 1-10, how did you like the song we used to listen to your /r/ sounds?	<b>R:</b> I didn’t like that one at all. It was kind of hard. I would rate it....a 3
<b>Q:</b> On a scale from 1-10, how did you like the ‘lively letters’ song?	<b>R:</b> That one was okay, I guess. It was still hard. I would rate it like a 4
<b>Q:</b> On a scale from 1-10, how did you like the Jack Hartmann songs?	<b>R:</b> Oh, I would rate them both 1000! I loved those songs so much.
<b>Q:</b> Do you feel like you do better when we have songs in therapy?	<b>R:</b> Yes, I think it feels easier.
<b>Q:</b> Do you enjoy therapy more when we do music?	<b>R:</b> Yes, it is more fun than last time. I like the songs more than just saying words.

**Table 1:** Non-verbatim transcript of responses to client interview questions.

The client was first asked to rate the musical interventions used for elicitation of /r/: the /r/ auditory bombardment song and the *Lively Letters* song. The client rated these

items a 3 and a 4, respectively; it is likely that this low rating is due to the client's difficulty with production of /r/, so the client was not able to participate. The client was then asked to rate the Jack Hartmann videos used for initial /l/ blend and 'th' intervention. The client rated these '1000'; it is evident that the client thoroughly enjoyed both interventions, as the song types are more upbeat and fun, and the client was able to participate in these interventions.

Questions were then asked to gauge how the client felt the intervention affected their performance. The client reported that therapy feels 'easier' when the use of song is implemented in sessions. This response likely has a neurological basis, as discussed earlier; it also could be contributed to the natural feeling of singing along to a song. Finally, the client was asked if they enjoyed therapy more during the study compared to prior semesters with different clinicians and no musical intervention. The client responded that it was 'more fun' and they enjoyed singing their target words more than simply 'saying words' presented on flashcards as used in traditional therapy approaches.

Overall, the client responded well to rating the activities as well as comparing their enjoyment to past therapy sessions without music. Perhaps the most important response, however, is that the client felt that they did better with the musical interventions than without. Based on data presented earlier, the client *did* perform better; it is an exciting parallel to see that the client felt the interventions were effective. If therapy does not seem as difficult to a client, it is reasonable to conclude that the client's motivation, effort, and attention will increase; an increase of these factors will certainly lead to a positive effect on a client's therapy outcomes, as seen in the data presented from this study.

### *Clinical Implications*

As there are little studies that focus on music therapy for the treatment of articulation disorders, this study provides insight on the possibility of the use of musical interventions during sessions to improve speech sound production. Songs can be used to elicit more productions of targeted sounds in a shorter amount of time, allowing the client to have greater amounts of practice during sessions. Additionally, musical activities implementing the use of target words and sounds may help to increase client engagement, attention, enjoyment, and motivation. This increase, along with neurological factors allowing musical interventions to be effective, equips clients to increase production accuracy at a quicker rate than seen in traditional approaches.

This study could also serve to inspire musical intervention in the treatment of other common communication disorders. Songs could be used to teach routines, aspects of language, and other deficits that require speech therapy. Given that an SLP's typical caseload includes many children with articulation disorders, this study serves as evidence that the implementation of musical intervention in the treatment of articulation disorders can be beneficial for both client and clinician. The use of musical intervention has a neurological basis that allows the client to progress towards therapy goals at a faster rate, as well as enjoy therapy activities more. For the clinician, enjoyment is also a beneficial factor in the implementation of music intervention; this is in addition to ensuring efficient services and progress in therapy, as required for all Speech-Language Pathologists. As clinicians see more progress at quicker rates, this could also contribute to clinician motivation and confidence, which enables the provision of exemplary services and

prevents issues within the profession such a burnout. . Although music is an intervention type not often used in articulation therapy, it has the ability to increase production amount and accuracy if implemented within therapy sessions.

### *Limitations*

The findings of this study are limited in application to the singular client involved in the intervention. While this client benefitted from the implementation of music intervention, this benefit cannot be generalized to a larger population, such as clients with articulation disorders or even speech therapy clients as a whole. While there seems to be a potential relationship between the client's performance and the use of musical intervention, the current findings and data are preliminary. The short-term effects observed in this study should be further tested with larger numbers of clients in order to provide an accurate report on the effectiveness of musical intervention. Future analysis is necessary to further explore the benefits of musical intervention for articulation clients.

### **Conclusion**

Music and speech processing are two neural events that are connected through shared neural pathways. The sharing of these brain areas proves to be beneficial in the processing of music, as this processing can strengthen both music and speech skills alike. This neural connection has provided a basis for many interventions in the field of Speech-Language Pathology, including treatments for populations of stroke patients, clients with Parkinson's disease, and individuals with autism spectrum disorder.

This study aimed to find evidence of a potential relationship between musical intervention and increased speech sound production accuracy. Musical interventions implementing the use of auditory bombardment and musical instruction were chosen to be included in the treatment of a school-aged client with difficulties producing /r/ at syllable level, initial /l/ blends and initial /ð/ ('th'). Data were collected over 14 individual 50-minute sessions in which musical interventions were alternated between sessions.

When collected data on percent of correct productions were separated between musical intervention and non-musical intervention, all targeted speech sounds showed similar trends of higher percentages among musical intervention data. This shows that the inclusion of music may improve client outcome in articulation therapy by improving accuracy at a quicker rate. This can be attributed to several factors, including:

- The utilization of shared neural networks between speech and music
- Increased client motivation
- Increase interest in therapy activities
- Increased client enjoyment during therapy sessions

Music has been used to address a range of outcomes for individuals with communication disorders. Findings from this study suggest that individuals with articulation disorders may benefit from the implementation of music intervention during speech therapy sessions. Regardless of the population served, SLPs strive to improve communication abilities, and therefore the lives, of those who undergo their services. It is vital to those services to choose an intervention style that not only is effective but provides value and enjoyment to those that benefit from it. Music enhances

communication abilities by unlocking potential within a client's neurology to both complement and improve speech skills.

Hans Christian Andersen, a figure so known for and dependent on his use of words in writing, is known for the quote: "where words fail, music speaks" (Brown, 1992). This study provides evidence of that exact statement. As both a passionate musician and future speech language pathologist, comfort can be found in the fact that for those whom communication is difficult, and for whom words do in fact fail, music speaks.

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